Wastewater Technology Centre

1989 Program Overview

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WASTEWATER TECHNOLOGY CENTRE

1989 PROGRAM OVERVIEW

Wastewater Technology Centre
Technology Development Branch
Conservation and Protection
Environment Canada

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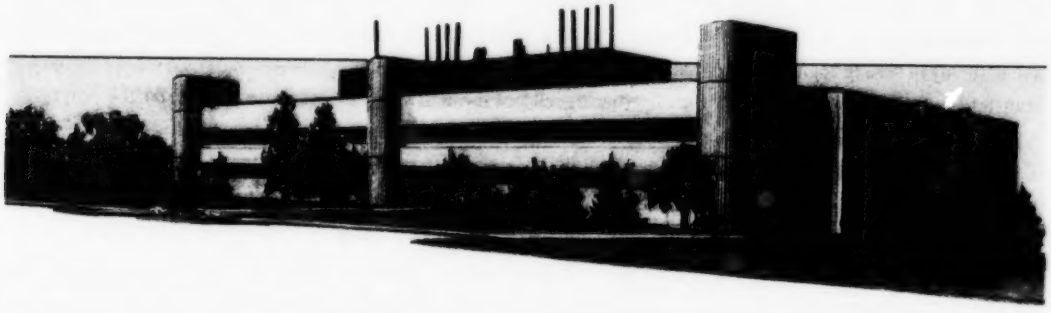
INTRODUCTION

The Wastewater Technology Centre (WTC) is one of six national research institutes within the Conservation and Protection Service of Environment Canada. The WTC and its associated facility, the River Road Environmental Technology Centre in Ottawa, are part of the Technology Development Branch. The WTC undertakes research and development of environmental protection technology in areas related to water pollution control and waste management. It also serves in an advisory capacity to various levels of government with regard to the technological basis for regulatory control of contaminants emanating from wastewaters and their associated residues.

The WTC is the foremost facility for water pollution control research in Canada and provides the focal point for water pollution control technology in Canada's international trade negotiations.



INSIDE THE WTC

The WTC consists of three research and three support divisions:

- Biological Processes
- Physical/Chemical Processes
- Residue Management

- Laboratory Services
- Computing and Informatics
- Support Services

Scientists, engineers and various support staff in these divisions share a unique research facility consisting of a wide variety of wastewater and sludge treatment pilot plants, laboratories and offices. Emphasis is placed on developing bench scale and pilot scale processes utilizing industrial wastewaters, municipal and industrial sludges and other contaminated materials. Mobile pilot scale process units and laboratories are employed to facilitate field projects and demonstrations at locations across Canada. In addition, the WTC is currently conducting a full scale demonstration of some of its technologies at the treatment facility in the town of Banff, Alberta.

In developing technologies, emphasis is placed on improving both the environmental and economic performances of treatment facilities. This involves the development of innovative process technologies designed to minimize waste generation and to optimize the treatment capability for industrial and municipal waste streams. Outstanding examples of process technologies that have proven to be highly cost-efficient and environmentally effective include the application of anaerobic processes to pretreat high-strength industrial wastewater, the low temperature conversion of municipal sludge to fuel oil, and the quantification and modelling of the natural degradation process for the treatment of gold mining effluents.

Regulatory issues are addressed through a number of research programs. These programs offer direct support to the development of regulations through the identification and measurement of environmental threats and the development of remedial and preventive technologies. The AERIS model (Aid for Evaluating the Redevelopment of Industrial Sites) is one example of innovative research in support of the regulatory process. The WTC has also provided expertise to the Ontario Ministry of Environment's MISA program (Municipal-Industrial Strategy for Abatement) in setting regulations for various industrial and municipal sectors. Environment Canada is planning to transfer to other areas of the country the expertise developed through WTC's experience with the MISA program.

Technology transfer is an important activity of the WTC in ensuring that improved technologies and processes are made available and marketed to users. It also provides a means by which knowledge can be shared and research needs are identified. Activities include the publication of scientific and technical information, organization of and participation in seminars and workshops, support to professional organizations and regular communication with the scientific and industrial communities in Canada and abroad.

PARTNERSHIPS

The WTC works closely with industry, all levels of government, academia, professional organizations and international agencies. These associations represent an essential ingredient to the success of the WTC in developing solutions to environmental problems.

The WTC recognizes the importance of close collaboration with industry to ensure that the best investments are made in support of environmental research. This direct involvement with industry gives researchers at the WTC a valuable perspective on the problems associated with operating treatment facilities in the most cost-efficient manner. It also increases the probability that any new or modified technology or process that might be proposed or developed will be implemented.

The WTC relies on Canadian universities as a source of research and expertise. As an example of its commitment to strengthening this relationship, the WTC co-sponsors the Environmental Engineering Systems Research Chair at McMaster University in Hamilton, Ontario. Other sponsors include Texaco Canada and the Natural Sciences and Engineering Research Council. Over the next two years, the WTC will continue its efforts to promote university chairs for other environmental concerns.

The international community is an important source of expertise and offers potential for Canada to expand its marketing capabilities. The WTC has maintained liaison with several international professional associations, government agencies and committees. These include the United States Environmental Protection Agency, the European Economic Community, technical organizations in several European and Scandinavian countries, the NATO Committee on Challenges to Modern Society, the International Association for Water Pollution Research and Control and the Water Pollution Control Federation.

FUTURE CHALLENGES FOR THE WTC

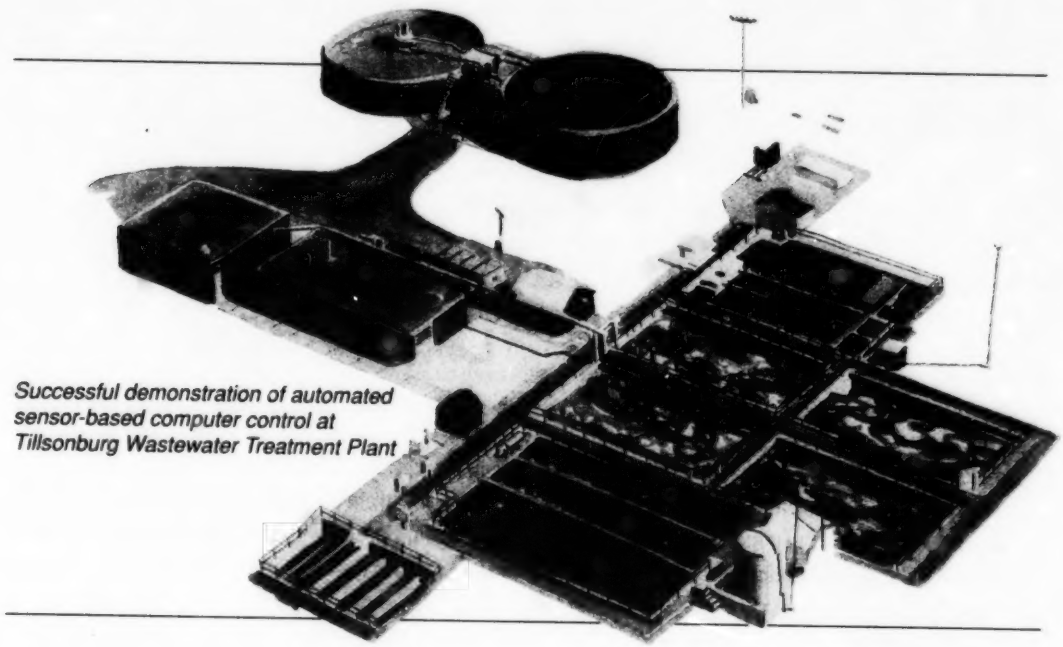
Environmental protection is a high priority at all levels of government in Canada. In promoting the concept of sustainable development - the integration of economy and environment to ensure the quality of the resource base for future generations - federal and provincial government agencies will continue to depend on improvements and optimization of water pollution control and residue management technology.

The WTC has the expertise and facilities to provide research and technological development to support a wide range of government programs and priorities. These include Halifax Harbour, the St. Lawrence Action Plan, the Great Lakes Remedial Action Plans, Ontario's Municipal-Industrial Strategy for Abatement Program, western Canadian water quality concerns and the Fraser River.

Biotechnology, information systems and advanced industrial materials, collectively referred to as the "enabling technologies", are currently the focus of policy and research initiatives in many industrialized countries. These areas are also fundamental to wastewater treatment, groundwater treatment and residue management. For example, biotechnology is the focus of much of the research and technology development undertaken at the Wastewater Technology Centre. Expert systems development for the selection of treatment methodologies and in-plant process optimization is another important component; such systems offer tremendous potential for maximizing cost-efficiency while maintaining environmental quality control. The area of advanced industrial materials development is also important for waste control and treatment; potential applications include landfill liners, waste stabilization and new types of membranes and coagulants for physical/chemical wastewater treatment.

BIOLOGICAL PROCESSES DIVISION

The Biological Processes Division evaluates, develops and demonstrates biotechnology for municipal and industrial wastewater treatment. Raw effluents containing excessive levels of biodegradable organic pollutants, or nutrients such as nitrogen or phosphorus, can be treated most economically by utilizing the natural biocatalytic properties of aerobic or anaerobic micro-organisms.



Successful demonstration of automated sensor-based computer control at Tillsonburg Wastewater Treatment Plant

The Division comprises scientists and engineers who combine a knowledge of microbiology and biochemistry with the principles of biochemical process engineering and statistical analysis to develop practical approaches to wastewater treatment problems. Bench scale, pilot scale and full scale projects, using both fixed-film and suspended growth biological processes, are frequently undertaken to facilitate the development and application of innovative biotechnologies that have the potential for both environmental and economic success.

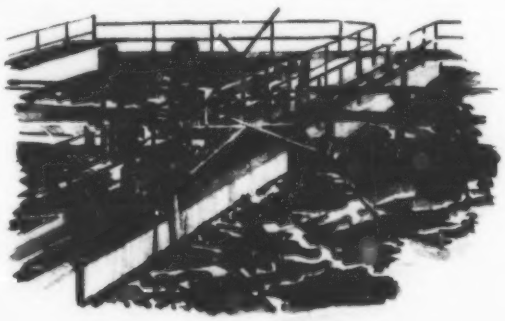
The major programs currently managed by the Biological Processes Division include:

- Computer Control of Biological Treatment Processes
- Trace Contaminant Control
- Pulp and Paper Wastewater Treatment
- Compliance Monitoring Methodology
- Development of Advanced Biotreatment Technologies

COMPUTER CONTROL OF BIOLOGICAL TREATMENT PROCESSES

Biological processes are widely used for municipal and industrial wastewater treatment in Canada. Often the treatment capacity of these systems may be under-utilized, or the operating costs and energy consumption rates may be higher than necessary. Their performance may also be limited by a lack of adequately trained operating staff. The treatment capacity of Canada's existing biological wastewater treatment infrastructure could be extended considerably through the application of advanced automation techniques and expert systems.

Dissolved oxygen control shows up to 30% savings in treatment plant power costs



The objectives of this program include the development and demonstration of computer-based process audit techniques for assessing the true capacity of an existing wastewater treatment plant and for determining the energy savings achievable with automated process control. By eliminating process operational bottlenecks and by introducing automation to optimize plant capacity, capital intensive plant expansions may be deferred or cancelled.

Another objective is the development of knowledge-based expert systems for biological treatment processes. When properly designed and verified, expert systems could offer advice to plant operators and provide the potential for rapidly solving operational problems that cannot be resolved using conventional methods.

Recent Activities and Accomplishments

- Aeration energy savings ranging from 15 to 35 percent were demonstrated with computer-based control at the WTC demonstration facility in the Tillsonburg Water Pollution Control Plant.
- The treatment process audit methodology was transferred to a private sector company and has subsequently been applied to ten full scale municipal wastewater treatment plants.
- WTC staff chaired a steering committee for a review of plant capacity at the Windsor, Ontario, Little River Water Pollution Control Plant to demonstrate the process audit methodology to the Ontario Ministry of Environment's Approvals Branch.

- Experimentation was completed to assess improvements in water pollution control plant operation with automated control and to confirm that on-line instrumentation maintenance requirements are manageable within most existing municipal wastewater treatment plants.

- Technical advice was provided to the Canadian Parks Service in the design of the treatment process and automated control system for the new Banff Townsite Water Pollution Control Plant.

- The WTC supported work at McMaster University to assemble a comprehensive library of treatment process models that can be used by plant operators and design engineers without extensive knowledge of mathematical modelling and computer programming.

- With WTC support, researchers at McMaster University have developed and tested two expert systems. One program assists in the design of treatment processes. The second package assists in diagnosing operating problems on the basis of qualitative information such as odours, a microscopic examination of the sludge, and the nature and extent of foaming on the treatment tanks.

- WTC and McMaster University researchers edited a book, "Dynamic Modelling & Expert Systems in Wastewater Engineering", on the application of dynamic models and expert systems to wastewater engineering.

Future Challenges

- Complete pilot scale and full scale testing to verify the dynamic models and expert systems being developed by McMaster University.

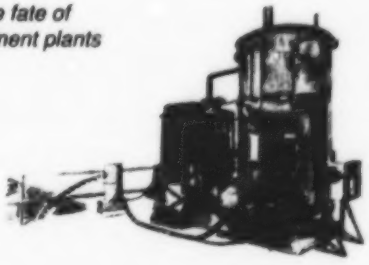
- Develop and demonstrate automated process control algorithms for high rate anaerobic treatment processes applied to toxic and inhibitory industrial wastewaters.

- Implement the process audit methodology to assist in the timely and effective resolution of Environment Canada priorities, such as the Hamilton Harbour Remedial Action Plan.

TRACE CONTAMINANT CONTROL

Municipal wastewater treatment plants receive toxic pollutants from many domestic and industrial sources. Although pretreatment can effectively control industrial contaminants, it cannot be easily applied to commercial and household sources. An understanding of the fate of these contaminants during wastewater treatment and their effect on treatment processes can assist municipalities to define sewer use control programs to ensure that plant operation and treated effluent discharge requirements are not compromised.

In house research demonstrates the fate of toxic contaminants in sewage treatment plants



Improvements in the control of toxic contaminants would be facilitated by models that would predict the fate of contaminants during municipal wastewater treatment. Biological Processes Division staff are working to incorporate pilot and full scale process data into a computer-based modelling system which simulates the behaviour of contaminants under various operating conditions. The objective of the models is to predict the emission rates of toxic contaminants that occur in treated effluents, waste sludges and process off-gases at municipal water pollution control plants.

Recent Activities and Accomplishments

- A pilot plant study was completed to verify sampling and analytical protocols for measuring volatile organic chemical emission rates from treatment plants.

- A long-term investigation for the Ontario Ministry of the Environment into the emission of volatile organic chemicals from aeration basins at municipal wastewater treatment plants has been completed. Emission rates for 34 of the Ministry's priority volatile organic chemicals were measured and correlated to treatment plant design and operating parameters.

- Pilot scale experiments provided detailed fate data on 10 of the volatile organic chemicals identified during the full scale monitoring program.

- Bench scale fate studies were initiated on the volatile contaminant 1,4-dichlorobenzene which was found to be the most frequently occurring and the most highly concentrated volatile organic chemical in Ontario municipal treatment plant wastewaters.

Future Challenges

- Complete an extensive series of bench and pilot scale experiments to generate physical and biological constants to calibrate forecasting models, which are not yet available for many of the substances included on priority pollutant lists.

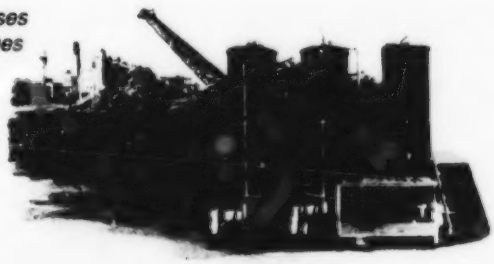
- Develop and utilize radioactive labelling techniques for confirming the mechanisms of removal of specific contaminants in biological treatment systems.

- Produce trace contaminant fate data to describe the behaviour of specific priority pollutants identified for regulation under the Municipal-Industrial Strategy for Abatement Program and the Canadian Environmental Protection Act.

PULP AND PAPER WASTEWATER TREATMENT

The pulp and paper industry is one of Canada's largest manufacturing sectors. Recent attention has been focused on conventional and toxic pollutants discharged from pulp and paper mills. Environment Canada, the Ontario Ministry of the Environment and several other jurisdictions have announced programs for revising existing pulp and paper effluent regulations to substantially reduce the discharge of pollutants to coastal and inland waterways.

Pilot scale research is utilizing biological processes to investigate removal of toxic chlorinated residues from pulp and paper wastewaters



One of the objectives of the WTC pulp and paper program is to support the revision of effluent regulations for conventional pollutants by re-assessing the performance capabilities of conventional biological treatment processes, such as aerated lagoons and activated sludge systems. The results could be used to define new effluent standards for mills based on the implementation of secondary treatment. A second objective is to develop and demonstrate advanced anaerobic and aerobic biotechnologies for removing toxic compounds, such as chlorinated organic chemicals found in bleached pulp mill effluents or the highly concentrated wood extractives in chemi-thermomechanical pulping (CTMP) wastewaters. Efforts are also being devoted to the incorporation of advanced physical/chemical techniques, such as membrane separation, into biological treatment systems to improve process performance and reliability.

Recent Activities and Accomplishments

- A study of 43 pulp and paper wastewaters determined the technical potential for utilizing energy-efficient anaerobic treatment technology in the pulp and paper sector.

- Under contract to the WTC, NovaTec Consultants of Vancouver reviewed the economics of aerobic and anaerobic treatment of CTMP wastewaters and determined that anaerobic pretreatment with aerobic polishing could be the most cost-efficient alternative for many non-integrated CTMP mills.

- As a result of pilot scale assessment of four high rate anaerobic processes for MacMillan Bloedel's neutral sulphite semi-chemical pulp mill at Sturgeon Falls Ontario, an upflow anaerobic sludge blanket process was selected for full scale effluent treatment.

- Technical assistance was provided to four full scale anaerobic treatment programs in the Canadian pulp and paper industry.

- A sampling program at three Ontario bleached kraft mills assessed the discharge rates of adsorbable organic halogen in bleach plant wastewaters and determined the potential for applying anaerobic dechlorination biotechnology.

- A dual-train, activated sludge pilot plant was constructed for a co-operative wastewater treatment research program at a CTMP mill in Alberta.

Future Challenges

- Develop improved treatment technology and expert systems for the removal of conventional pollutants from pulp and paper wastewaters.

- Assess the fate and effect of toxic components of high strength CTMP wastewaters on anaerobic and aerobic treatment process microorganisms.

- Develop and demonstrate aerobic or anaerobic/aerobic biological treatment systems for BOD removal, toxicity removal, and nutrient control for high strength CTMP wastewaters.

- Assess the potential of membrane separation technology for toxics control for selected wastewater streams from CTMP mills and kraft pulp bleach plants.

- Develop new membrane materials and casting procedures for the manufacture of membranes specifically suited to pulp and paper applications.

- Develop and demonstrate high rate anaerobic process technology for anaerobic dechlorination of selected wastewaters from bleached kraft mills.

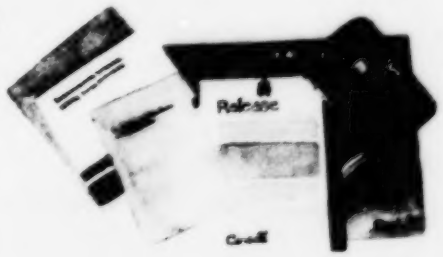
- Develop process design relationships for optimizing the removal efficiencies for adsorbable organic halogen in conventional biological treatment processes such as activated sludge or aerobic lagoons.

- Develop and demonstrate treatment systems for removal of colour and non-biodegradable organics from pulp and paper wastewaters.

COMPLIANCE MONITORING METHODOLOGY

Biological treatment technologies have been widely adopted for both municipal and industrial wastewater treatment. Acceptable design approaches for these systems have been well defined by many years of process research. Nonetheless, many treatment plants do not perform with the consistency intended by their designers. Better methods of gathering and analyzing information about the process could assist regulators and plant operators to improve the status of compliance of existing facilities with pollution control legislation.

Industrial sectors receive guidance in managing complex data bases for compliance monitoring



The WTC is working to identify useful statistical approaches for interpreting treatment plant data. The objective of the work is to demonstrate techniques that would enable regulators and plant operators to extract information from data more effectively. In addition, the WTC is a joint sponsor, along with the U.S. Environmental Protection Agency, of a Secondary Clarifier Research Technical Committee. The Committee's mandate is to improve the compliance status of biological treatment plants by developing better information about the design and monitoring of secondary clarifiers, which are critical to final effluent quality.

Recent Activities and Accomplishments

- A study on behalf of the Ontario Ministry of the Environment evaluated current methods for handling and analyzing data reported by municipal treatment plants. The study report suggested changes in data handling that would allow improved management of phosphorus discharges to the Great Lakes.

- The WTC co-sponsored a workshop on statistical methods for analyzing data from treatment plants. Topics discussed included the use of computers for data handling, procedures used by regulators for data interpretation and regulations development, and special problems related to the evaluation of very low levels of trace contaminants.

- A report was prepared for Ontario petroleum refineries offering guidelines on the storage, management and interpretation of data from refinery wastewater treatment systems.

- The Clarifier Research Technical Committee developed a draft test protocol for rating secondary clarifier performance.

- The Clarifier Research Technical Committee collected secondary clarifier design standards from various U.S States, Canadian provinces, and European and Asian countries. This information will be used to improve secondary clarifier design and monitoring methods.

Future Challenges

- Develop a data management system for the Ontario Petroleum Association for analysis of results from the ongoing MISA Petroleum Refinery performance monitoring program. This database will support the development of the MISA Petroleum Refinery Effluent Control Regulation.

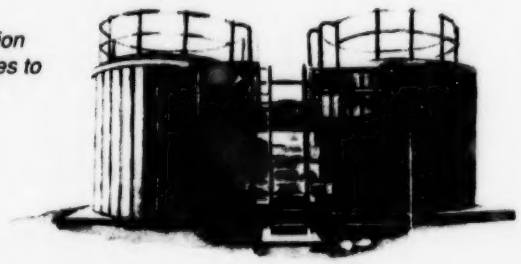
- Develop approaches for incorporating effluent toxicity monitoring parameters within the MISA Petroleum Refinery Effluent Control Regulation.

- Evaluate and revise the proposed field test protocol for rating secondary clarifier performance.

DEVELOPMENT OF ADVANCED BIOTREATMENT TECHNOLOGIES

Continued improvements in water quality can be achieved either through the application of conventional wastewater treatment systems, or by the development and demonstration of innovative technologies that show potential for more efficient wastewater management. The objective of this program is to identify or develop new approaches to biological wastewater treatment that show potential for more effective performance or cost-efficient operation.

Autothermophilic aerobic digestion systems aid western communities to minimize sludge disposal costs



Recent Activities and Accomplishments

- Under WTC direction, an autothermal thermophilic aerobic digestion facility was constructed at the new Banff Townsite Water Pollution Control Plant.
- Under contract to the WTC, Dayton and Knight Ltd. of Vancouver are evaluating the performance of a small number of existing autothermal thermophilic aerobic digestion facilities in British Columbia.
- WTC staff assisted in the preparation of a U.S. Environmental Protection Agency manual on fine bubble aeration systems for reducing energy consumption and extending the capacity of activated sludge systems.
- Under contract to the WTC, researchers at the University of Calgary demonstrated techniques for accelerating biofilm attachment and development in high rate anaerobic reactors. These findings have potential for minimizing a major impediment to the implementation of anaerobic biotreatment technology.

Future Challenges

- Complete pilot scale verification studies of the revised approaches for biofilm development in high rate anaerobic reactors.
- Investigate the extent to which autothermal thermophilic aerobic digestion sludge treatment biotechnology can produce a stabilized and pasteurized sludge that would be suitable for land disposal.
- Develop and demonstrate fixed-film biological treatment systems for dilute waste streams and contaminated groundwater.
- Develop and demonstrate sequencing batch reactor technology for contaminated groundwater treatment.
- Demonstrate the use of step-feed operating techniques to minimize bypassing of untreated wastewater during treatment plant overloading due to excessive stormwater flow.

PHYSICAL/CHEMICAL PROCESSES DIVISION

The Physical/Chemical Processes Division undertakes research, evaluates methods and develops new technologies for the physical and chemical treatment of wastewaters and contaminated groundwater. The target contaminants or other undesirable constituents of these waters are normally not considered treatable by biological methods or may require physical/chemical treatment in addition to biological treatment.

The pollutants of concern include complex synthetic organic compounds and heavy metals. These substances may be dissolved in the wastewater or associated with suspended particulates. A wide range of physical and chemical operations and processes are available to either reclaim these contaminants for reuse, destroy them or isolate them as residues for disposal.

Field demonstration of physical/chemical treatment technology is used to solve industrial environmental problems

The Division comprises engineers, scientists and technologists with expertise in the areas of precipitation, coagulation, sedimentation, filtration, membrane techniques (such as reverse osmosis, ultra- and micro-filtration, electrodialysis), adsorption, ion exchange, and oxidation processes including chemical and photo-chemical techniques.

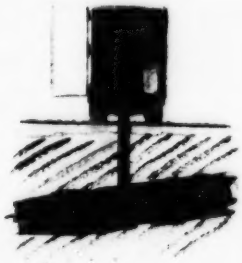
There are currently six programs within the Physical/Chemical Processes Division:

- Contaminated Groundwater Treatment Technology
- Mining
- Oil and Gas
- Metal and Fabrication and Finishing
- Industrial Pretreatment and Recycling Technologies
- Development of Advanced Physical/Chemical Treatment Technologies

CONTAMINATED GROUNDWATER TREATMENT TECHNOLOGY

Approximately 26 percent of Canada's population relies on groundwater as a source of drinking water. The contamination of groundwater by hazardous substances can have very serious repercussions and is a major environmental concern. Sources of groundwater contamination include: poor waste management and disposal practices at active and abandoned hazardous waste sites; spills and leaks of hazardous chemicals; and the application of herbicides and pesticides to agricultural land.

On site field demonstration of contaminated aquifer remediation technology demonstrates extracted water can be treated to drinking water standards



The primary objective of this program is to develop and demonstrate cost-efficient technologies for the treatment of contaminated groundwater. The selection of appropriate technology is a function of the site hydrogeology as well as the type, concentration and extent of contamination. Treatment may include physical/chemical as well as biological processes applied in conjunction with groundwater extraction techniques (pump and treat) or within the aquifer (in situ).

Recent Activities and Accomplishments

- A pilot scale experimental program was completed on the use of counter current air stripping to remove volatile organic compounds from contaminated groundwater at Transport Canada's Gloucester landfill site. Air emissions were treated using activated carbon. Data from the study were used in the design of a full scale treatment system for decontamination of the groundwater. Construction is expected to begin in 1990. A report on the study is available.

- A major contract was initiated to assess the efficiency of the pump and treat remediation technology presently treating a contaminated drinking water supply aquifer near Ville Mercier, Quebec. Preliminary results indicate that the treatment process is not completely effective in removing the chlorinated and non-chlorinated hydrocarbons and that significant "pockets" of dense non-aqueous phase liquids (DNAPL) remain in the soil and will continue to contaminate the aquifer unless additional remedial measures are undertaken. Pilot scale treatment studies demonstrated that the extracted water could be treated to drinking water standards.

- A workshop was conducted to develop a plan for the development and demonstration of technologies for the remediation of groundwater and soil contaminated by hydrocarbons. A national steering committee and four technical subcommittees were established to implement the plan. Participants in the program include the federal government and several provincial governments, academics, the Petroleum Association for the Conservation of the Environment, the Canadian Petroleum Association, the American Petroleum Institute, and the U.S. Environmental Protection Agency.

Future Challenges

- Develop a research and demonstration program to address DNAPL contamination in the soil and fractured bedrock.

- Evaluate, develop and field demonstrate new technologies for above ground and in situ treatment of contaminants in soil and groundwater.

- Develop treatment technologies for volatile compounds present in the off-gas from groundwater and soil remediation technologies.

- Provide support to the National Groundwater and Soil Remediation Program (GASReP) by ensuring adequate financial and staff support from among the member sectors, expanding the scope of the program to include additional sectors such as the chemical industry, and undertaking specific research and development in support of program priorities.

- Conduct a conference on photo-oxidation research, establish an annual symposium on research conducted under the National Groundwater and Soil Remediation Program, and continue participation on the NATO Committee on Challenges to Modern Society Pilot Study on the Demonstration of Remedial Action Technologies for Contaminated Soil and Groundwater.

- Investigate the application of specific biotechnologies for groundwater treatment. These include in situ bioremediation within aquifers, the use of biologically activated carbon for drinking water supplies and the use of peat biological filters for off-gas treatment.

- Investigate the kinetics of formation and degradation of viny chloride under anaerobic conditions in order to identify possible treatment technologies for the biodegradation of perchloroethylene

MINING

The mining and milling of metallic ores generates large quantities of aqueous wastes which can contain high levels of various toxics such as cyanide and heavy metals. These wastes are generally discharged into tailings ponds where solids settle out of solution. The remaining liquid fraction is either recycled or discharged to the environment after appropriate treatment. The significance of this industry is reflected in part by the fact that the number of gold mines in Canada has doubled since 1985.

As one of the world's major producers of precious and base metals, Canada is also a leader in the development of technologies to remove contaminants from metal mining wastes. The Physical/Chemical Processes Division has been a key contributor in developing treatment technologies for the gold and base metal mining industries. The primary objective of the mining program is to develop improved and more cost-efficient methods of removing cyanide, heavy metals and other contaminants from effluents.

On site demonstration of treatment technology is essential in developing effective solutions for the mining industry

Recent Activities and Accomplishments

- Three effluent treatment systems at the Hemlo area gold mines were evaluated.
- A mathematical model for the design of a gold mill effluent treatment system utilizing natural degradation processes was developed.
- A study and report on the use of high intensity ultraviolet lamps for removing iron cyanide from effluents was completed.
- A prototype cyanide analysis training video for industry and regulatory personnel was produced.
- Successful technology transfer conferences were held in Vancouver and Toronto on design considerations for the management of gold mill effluents. The 300 participants represented the mining industry, regulatory agencies, technology suppliers, research organizations and the university community. Proceedings are available.

Future Challenges

- Review and report on the state-of-the-art of the hydrogen peroxide process for treating gold mill effluents.

- Evaluate and demonstrate suitable cyanide/metals recovery and recycle technologies applicable to gold mill effluents to encourage industry to implement waste minimization techniques.

- Initiate a joint industry-government study to develop a database on the natural degradation of cyanide in gold mill effluents treated in calibrated standardized ponds.

- Develop a knowledge based expert system for process evaluation and design of gold mill effluent treatment systems for achieving the Best Available Technology Economically Achievable (BATEA).

- Develop and demonstrate an alternative cost-efficient technology for the existing lime process for acid mine drainage in base metal mines.

- Identify technology development requirements for physical/ chemical treatment of effluents from various mining sectors including uranium, base metals and coal.

- Identify advanced industrial materials such as specific coagulants, new polymer membranes and supported liquid membranes for use in treating mining effluents.

OIL AND GAS

Heavy oil and tar sand deposits in Alberta and Saskatchewan contain nearly 90 percent of Canada's oil reserves. The viscous oil in these deposits cannot be recovered by conventional techniques and must be extracted using special techniques such as steam injection. This method generates a wastewater, generally referred to as "produced water", which is contaminated with oil, suspended solids, total dissolved solids, silica and dissolved organics. Offshore oil production generates a produced water which contains elevated levels of oil and suspended solids.

Field research demonstrates water recycling technologies from the production of heavy oil

The overall objective of this program is to ensure the development of these resources in an environmentally sound manner. The specific objective of the heavy oil component of the program is to investigate, develop and demonstrate cost-efficient treatment technologies which would enable produced water to be recycled to once-through steam generators. The objective of the offshore component of the program is to evaluate state-of-the-art oil removal technologies and to develop a reliable on-line oil-in-water monitor for produced waters. This will lead to better control of the treatment process and enhanced environmental quality.

Recent Activities and Accomplishments

- A field pilot study was completed on the use of vapour compression evaporation for the removal of total dissolved solids from heavy oil produced water to allow recycling of the water. The results have been presented to industry and regulatory agencies to assist them in assessing the technical feasibility and practicality of implementing the technology given the current low price for heavy oil.

- A review of silica removal technologies was published. The results of experimental work on silica removal by activated alumina were presented at a technical meeting of the Canadian Heavy Oil Association. One oil company has shown interest in applying the technology.

- Several reports were published on the identity and concentration of toxic organic contaminants in produced waters. These data were used by industry and regulatory agencies to assess the requirements for guidelines for recycling produced water.

- The performance of two full scale induced gas flotation systems for treating produced waters at two heavy oil operations in Alberta were evaluated. The results are being used to assess the technical and cost-effectiveness of existing technologies and to guide research examining innovative technologies.

- The technologies being used in various parts of the world for the treatment of produced waters, including the North Sea and Gulf of Mexico, were reviewed. The review provides the basis for discussions with industry and regulatory agencies concerning the requirements for technology assessment and development in Canada.

Future Challenges

- Undertake field evaluations of existing membranes and develop improved membranes for treating produced waters from heavy oil and off shore conventional oil production.

- Evaluate and further develop hydrocyclone technology for the treatment of produced water from off-shore oil production.

- Test the most promising on-line oil-in-water monitors and develop a reliable monitor for heavy oil and off-shore oil applications.

- Develop an expert system to identify the best available technology economically achievable for treating produced water during in situ heavy oil recovery.

- Identify advanced industrial materials such as specific coagulants and new polymer membranes appropriate for use in the treatment of produced water.

METAL FABRICATION AND FINISHING

Effluents released during metal fabrication and finishing operations such as those from the iron and steel industry, the metal casting industry and plating operations are toxic. Contaminants include toxic metals, polynuclear aromatic hydrocarbons, heterocyclic nitrogenous compounds, cyanide and phenolics. Discharges from these industries are made either directly to surface waters or indirectly via municipal water pollution control plants which are not normally designed or operated to effectively remove these contaminants.

Innovative and cost-efficient treatment is developed in conjunction with industry

The objective of the metal fabrication and finishing program is to evaluate existing treatment methods, and to develop innovative, cost-efficient treatment methods and waste minimization strategies.

Recent Activities and Accomplishments

- A study of the feasibility of automated process control for the alkaline chlorination process in a local metal finishing facility was initiated. Process control and the application and integrity of commercial chlorine analyzers for use in the treatment plant will be assessed with regard to treatment cost reduction and enhancement of effluent quality.

- Bench scale testing was completed on several commercial chlorine analyzers. Three units were identified for field evaluation at the metal finishing plant noted above.

- Assistance was provided in the development of training packages for use by plant managers and wastewater treatment operators in the metal finishing industry. These are presently being marketed by the Canadian Water and Wastewater Association.

- Technical support and advice were provided to the Ontario Ministry of Environment's MISA Program for the development of monitoring regulations for the iron and steel, and metal casting industries.

Future Challenges

- Develop effective, economical on-line process control strategies for the treatment of metal finishing effluents. Develop and demonstrate a pilot scale alkaline chlorination facility that will produce effluents of consistently higher quality at lower cost.

- Develop and demonstrate effective, economically achievable technologies for improved effluent treatment in the iron and steel, metal casting and metal finishing industries.

- Identify advanced industrial materials such as specific coagulants and new polymer membranes applicable for use in treating effluents from the metal finishing and fabrication industry

INDUSTRIAL PRETREATMENT AND RECYCLING TECHNOLOGIES

A major focus in the treatment of wastewaters is the pretreatment of specific wastes at the source before they are discharged to municipal sewers or to the environment. Numerous industries such as metal finishing plants, paint and pigment manufacturers, chemical plants and commercial operations such as dry-cleaning establishments discharge their effluents to municipal sewers. Many of these wastes can be treated effectively while they are in a relatively pure and concentrated form and reuse of the recovered material is often possible. The contaminants in these wastes can be very difficult to remove or destroy after dilution and mixing within municipal sewers. Also, they can adversely affect the operation of municipal sewage treatment processes.

In house research and development demonstrates the potential for recycle/reuse technologies

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The objective of this program is to identify and develop new technologies, including advanced industrial materials, for recovering specific contaminants from industrial effluents. Recycling and recovery technologies are emphasized in this new program area.

Recent Activities and Accomplishments

- Pilot scale work was completed on a process to recover and recycle chlorinated organics from an industrial waste stream. Implementation at full scale, however, was deferred because the Company found that improvements to the production process which essentially eliminated discharge of the contaminant.

Future Challenges

- Evaluate and develop membrane technologies for specific industrial wastewaters. These technologies include electrodialysis, ultra-filtration, micro-filtration, per-evaporation, new polymer membranes and supported liquid membranes.

- Develop an expert system to evaluate alternative process schemes for effluent treatment to provide more cost effective designs.

- Identify opportunities for the use of freeze concentration for the recovery of toxics from various industrial waste streams.

- Evaluate treatment technologies for wastes containing chlorinated hydrocarbons.

- Investigate the use of tailored ultra- and nano-filtration membranes for removing toxic organics from selected process effluents at pulp and paper mills.

- Collaborate with selected industries to fully implement and demonstrate recovery/recycle technologies for virtual elimination of contaminant discharges.

DEVELOPMENT OF ADVANCED PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES

The general objective of this program is to improve efficiency and reduce operating costs of municipal and industrial wastewater treatment processes by optimizing their design and operational parameters. The program is divided into three tasks: 1) improvement in process knowledge; 2) the comprehensive design of process vessels; and 3) automated process monitoring and control. The current focus is on small particle research, precipitation, coagulation, flocculation and granular media filtration.

Pilot scale technology demonstrates filtration optimization and process control

Small particle research involves characterization of suspended particles, including knowledge of their size, shape, density and surface properties. Existing methods of measuring particles, such as by the turbidity of the effluent, are insufficient to achieve higher quality effluents.

The precipitation of soluble pollutants such as phosphorus and the aggregation of precipitate particles and other suspended material by coagulation and flocculation are common to many wastewater treatment processes. The efficiency of such processes depends on many physical and chemical conditions in the system, which typical experimental designs fail to simulate adequately. Process improvements can be achieved through comprehensive experimental procedures.

Granular media filtration is used in wastewater treatment, drinking water treatment and within industrial processes. Although widely used, the mechanisms responsible for particle removal by filters are complex and not fully understood. Hence, filter design has generally been based on trial and error methods which are time consuming and can create an inefficient product. Improved design and operating procedures will provide cost savings and better effluent quality.

Recent Activities and Accomplishments

- A cooperative program with McMaster University has been established to develop the expertise and analytical capabilities required to form a small particle technology basis for process development projects. This program has contributed to filtration and flocculation studies and has provided small particle characterization data to other projects.

- After initial studies at WTC, field trials were successfully completed on the use of a pilot scale, automated granular media filter to remove oil and suspended solids from produced water at a heavy oil site in Saskatchewan and one in Alberta.

- A preliminary filtration model describing the behaviour of suspended particles in a granular filter bed was developed. The model is being used to explore the mechanisms of filtration and to predict the performance of filters.

- Exploratory experiments have been undertaken to develop a flocculation model which should assist in the development of improved design procedures.

Future Challenges

- Develop analytical capabilities and expertise in the area of small particle analysis in order to better understand process performance.

- Utilize a combination of mathematical simulation, expert systems and automated bench scale and pilot scale equipment to develop new approaches to the development of physical/chemical process technologies.

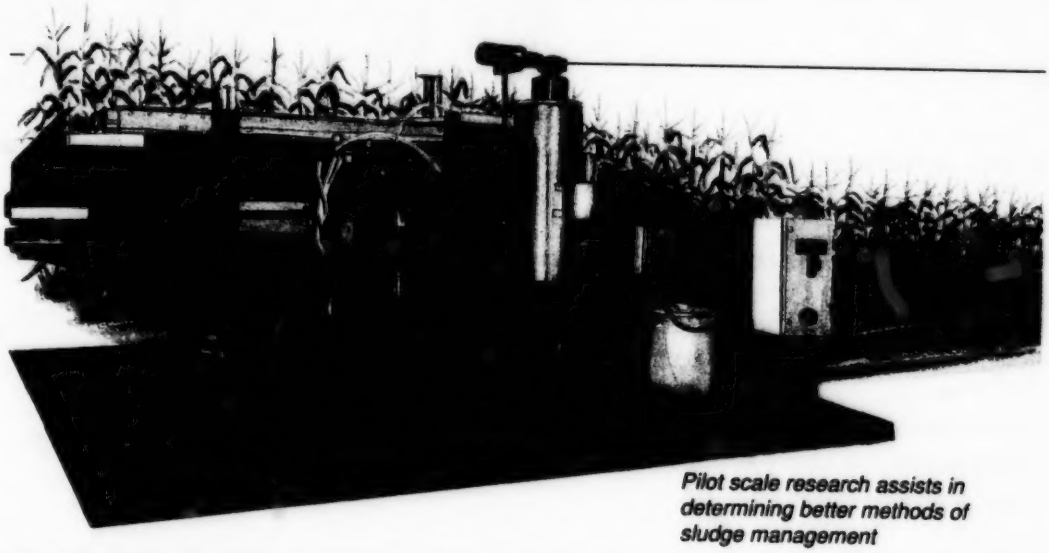
- Identify new advanced materials for application as specific coagulants.

- Develop techniques and methodologies for upgrading existing municipal and industrial wastewater treatment processes through: the utilization of comprehensive reactor design procedures; the development of a flocculation simulation program to predict flocculation system performance; the evaluation of a filtration simulation program to assist the selection of efficient filter designs; the evaluation of instrumentation for on-line monitoring of particulates (suspended solids) and other wastewater variables; and the development of a process control system to reduce the costs of chemical additives and improve effluent quality. New techniques will be applied in several process development programs including the assessment of filtration as a polishing process at municipal and industrial wastewater treatment plants discharging to Hamilton Harbour.

RESIDUE MANAGEMENT DIVISION

Research and technology development activities within the Residue Management Division support the management of sludges and other wastes, the treatment of contaminated soils and the remediation of decommissioned industrial sites.

Programs dealing with sludge and residue management involve the development of technologies and methods for their volume reduction, safe disposal and practical utilization. Remediation activities involve the development of strategies for the clean-up of decommissioned industrial sites, particularly the in situ treatment of contaminated soils.



Pilot scale research assists in determining better methods of sludge management

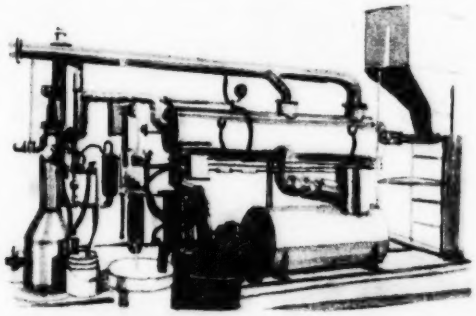
Programs currently being undertaken by the Residue Management Division include:

- Sludge Treatment
- Land Application of Sludge
- Waste Characterization
- Waste Solidification and Stabilization
- Site Remediation

SLUDGE TREATMENT

The treatment of municipal wastewaters results in the production of large volumes of sludge. The management of this material, particularly in terms of dewatering and disposal, is costly and a potential environmental concern. Methods which enhance the management of sludge, such as improving the efficiency of dewatering and reducing the volume of material, will provide substantial benefits. Additional benefits are derived from conversion techniques that generate marketable products such as fuel oil.

Conversion of sludge produces liquid fuels



Two technologies developed by the Residue Management Division form the basis for the current sludge treatment program. These technologies are the Sludge Conditioning Controller and the Oil-From-Sludge process.

The Sludge Conditioning Controller effectively measures and adjusts the amount of polymer added to the wastewater stream to enhance the dewatering process. The controller has demonstrated significant cost savings by reducing polymer consumption.

The Oil-From-Sludge process is a tremendous technological achievement as it reduces the volume of sludge, saving disposal costs, while producing an economic commodity. The low temperature conversion of sludge to fuel oil results in operational savings of between $40 and $60 per tonne of sludge.

The objectives of the WTC Sludge Treatment Program are to refine these technologies, to demonstrate them at operational scale, to assess sludge-derived oil upgrading techniques and to assess environmental implications of combustion of the synthetic fuel oil.

Recent Activities and Accomplishments

- A demonstration of the Sludge Conditioning Controller at a municipal sewage treatment plant indicated a 24 percent reduction in polymer consumption. Subsequent marketing by Zenon Environmental Limited resulted in sales or trial installations in ten different countries.

- Canadian Patents and Development Limited have licensed the Oil-From-Sludge technology to Enersludge, a Canadian company. Patents have been issued in the United States and Canada and are pending in several other countries.

- An experimental program on a one tonne per day Oil-From-Sludge pilot plant was completed. The information will be used for the preliminary design of a full scale demonstration plant.

Future Challenges

- Transfer information on the Oil-From-Sludge technology to municipalities and demonstrate the system at full scale in Canada.

- Promote the further application of the sludge conditioning controller by providing technical information to end-users.

- Provide technical, financial and marketing support for the further demonstration, testing and commercialization of other sludge treatment technologies, including the rotary press.

LAND APPLICATION OF SLUDGE

The application of municipal sludge to agricultural land is a cost-efficient method of sludge utilization which allows the recycling of valuable plant nutrients. Approximately one-third of municipal sludge produced in Canada is utilized in this manner. The presence of toxic constituents in municipal sludge requires that guidelines be developed to minimize hazards associated with land application.

In house studies develop a data base for land utilization of sludge

Land application may also have potential for the treatment and disposal of heavy oil wastes and industrial sludges. However, current information on the nature and fate of the contaminants in these sludges, when applied to soil, is inadequate for the development of codes of practice or regulations.

The objectives of the land application of sludge program are to develop and demonstrate technology that permits the land application of municipal sludge in a sound environmental manner, to determine the fate of toxic chemicals in heavy oil wastes and industrial sludges when applied to soil, to determine the treatability of heavy oil waste and industrial sludges, to develop techniques for heavy oil waste treatment, and to assist in the development of guidelines and regulations for land application.

Recent Activities and Accomplishments

- A methodology was developed to measure volatile organic contaminants in sludge/soil/water matrices. This approach can be used to determine the fate of these contaminants in sludge applied to agricultural land.

- A microcosm technique for studying plant uptake of organic contaminants from sludge-amended soils was developed. The results from microcosm studies will be instrumental in determining the need for regulations relating to organic contaminants in sludges applied to land.

- Biometer flask, microcosm and incubation flask experiments on the fate of toxic organics in oily wastes applied to land have been completed. Degradation rates and half-lives for ten target compounds have been established.

Future Challenges

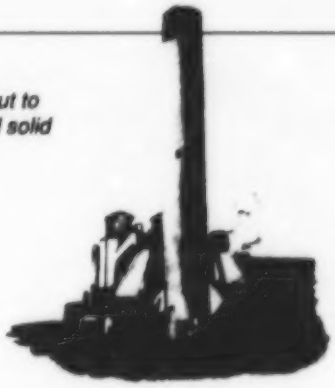
- Expand the scope of laboratory, greenhouse and field studies to develop a database for establishing guidelines/regulations for the application of sludge containing organic chemicals to agricultural land.

- Generate information for use in the development of guidelines for the land application of heavy oil wastes and other industrial wastes.

WASTE CHARACTERIZATION

Waste disposal sites have been identified as major contributors of toxics to the ecosystem. Knowledge of the nature and leachability of toxics within different wastes is very important in developing strategies and technologies for proper waste disposal.

Ash characterization provides input to operating guidelines for municipal solid waste incineration



The incineration of municipal solid waste and industrial hazardous wastes is one strategy that has been employed to reduce the volume of waste requiring landfilling. The residues (ashes) from incinerators have received only preliminary characterization with regard to their suitability for landfilling. Improved characterization is necessary to develop regulatory requirements for these residues.

The objectives of the waste characterization program are to identify the toxic constituents of various waste residues, to investigate their leachability, to assess methods for conducting leaching tests and to provide advice on the proper disposal of various waste residues. Expert systems will be used in conducting these waste characterization assessments.

Recent Activities and Accomplishments

- The physical, chemical and leaching characteristics of bottom and fly ashes from nine municipal solid waste incinerators were evaluated. Solidification and stabilization techniques for immobilizing inorganics in the fly ashes were examined. The results were incorporated into "Operating and Emission Guidelines for Municipal Solid Waste Incinerators" published by the Canadian Council of Ministers of the Environment.

- The LANDIS (LANd DISposal) expert system is being developed under contract to the WTC. The main component of LANDIS is a data interpretation and decision-rendering expert system which also co-ordinates information flow between itself and several specialized modules including a database containing the results of waste analyses and various leaching tests, and the HELP (Hydrological Evaluation of Landfill Performance) model developed by the USAE Waterways Experiment Station. LANDIS will allow users to identify appropriate leaching tests for wastes, to evaluate the suitability of wastes for landfill disposal, and to examine alternative waste processing options for wastes failing the disposal criteria. The HELP model graphical interface and the database structure for the LANDIS program have been completed.

Future Challenges

- Enhance and expand the applicability of the LANDIS waste characterization expert system by accumulating additional data and knowledge from experts and demonstrate the technical viability of the system.

- Initiate field studies on the disposal of municipal solid waste ashes based on data developed under the National Incinerator Testing and Evaluation Program in order to identify the acceptability of various disposal scenarios.

- Conduct research and development on the vitrification of municipal incinerator and coal-fired power plant wastes and identify potential commercial uses as an alternative to landfilling.

- Investigate the potential for developing advanced industrial materials for use in landfill site liners.

WASTE SOLIDIFICATION AND STABILIZATION

Landfilling is the disposal method of choice for the many hazardous wastes that cannot be recycled or reused for practical or economic reasons. Leaching of toxic contaminants from these wastes into soil and surface waters presents a very serious environmental problem. Solidification and stabilization techniques improve the physical and chemical characteristics of the wastes such that leaching and off-site transport of toxic contaminants is minimized or eliminated. These techniques need to be evaluated using standardized protocols to allow regulatory agencies to develop appropriate guidelines for environmental protection.

Extensive studies demonstrate the effectiveness of waste solidification/ stabilization technologies

The objectives of the Waste Solidification and Stabilization Program are to develop, validate and standardize test methods for characterizing the effectiveness of solidification techniques, to promote the utilization of the tests developed, to promote the use of demonstrated solidification and stabilization techniques for the safe disposal of hazardous wastes, and to develop predictive models for assessing the potential for leaching of solidified wastes under field conditions.

Recent Activities and Accomplishments

- A study conducted by the WTC, in conjunction with a number of other governments and solidification vendors, evaluated 16 laboratory test methods for characterizing solidified wastes. The study determined the variability of each test method and the variability among wastes solidified by different vendors. A significant database on solidified waste characteristics was developed.

- A report based on the data generated in the above study ("A Proposed Evaluation Protocol for Stabilized/Solidified Wastes") will provide a basis for establishing solidified waste performance criteria which can be used to evaluate various disposal scenarios.

- Another report in preparation is "A Compendium of Waste Leaching Tests". It addresses the generic problem of waste leaching and provides an overview of various types of leaching tests and their interpretation.

- The applicability of existing solidification processes to a number of wastes were evaluated for the Ontario Waste Management Corporation. This information will be used in the development of the Corporation's hazardous waste disposal facility.

Future Challenges

- Develop and promote a rational approach to evaluating the long-term environmental impacts of disposing of solidified and stabilized hazardous wastes.

- Develop an expert system to identify waste solidification and stabilization strategies.

- Establish a coordinated research program with other institutes undertaking work in this area.

SITE REMEDIATION

Substantial quantities of soil contaminated with chlorinated organic compounds such as polychlorinated biphenyls and pentachlorophenol are awaiting a suitable method for clean-up and disposal. Given the volume of soil involved, the potential for spillage during transportation to incinerator facilities and the high cost of incineration, alternative treatment methods need to be developed. In situ biodegradation using microbial organisms offers the potential for a safe, cost-efficient solution.

Industrial site requires extensive field studies to develop clean up criteria

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Pressure for land development is in most urbanized portions of Canada. In these areas, decommissioned industrial sites are in demand for redevelopment. Many of these sites have contaminated soils which must be assessed and treated prior to reuse. The Residue Management Division has managed a joint government/industry program to develop an expert system that determines clean-up criteria for industrial site remediation. The Aid for Evaluating the Redevelopment of Industrial Sites (AERIS) expert system calculates the concentrations of a pollutant in soil, water, air and plants, and predicts the potential human exposure to the pollutant in anticipated land use scenarios.

The objectives of the Site Remediation Program are to develop in situ biodegradation techniques for the decontamination of soils containing chlorinated organic compounds and to demonstrate and expand the usefulness of the AERIS program to industry and regulatory agencies.

Recent Activities and Accomplishments

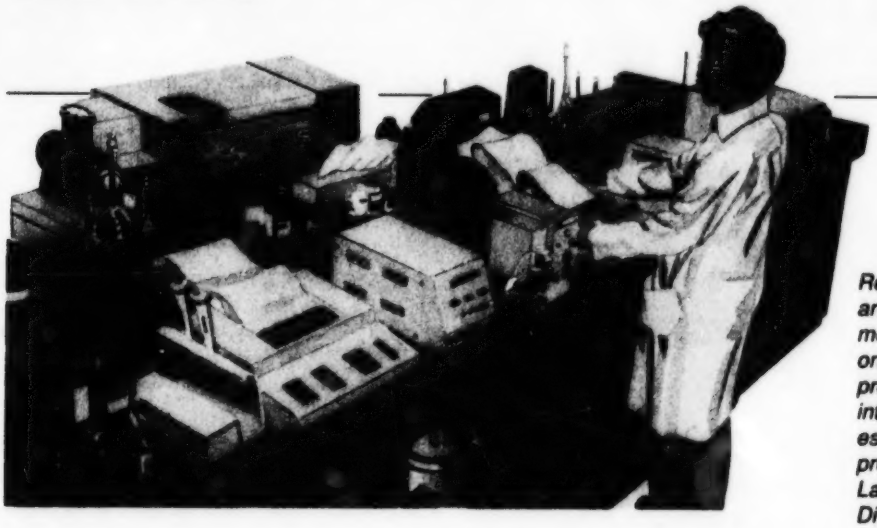
- Bioremediation techniques for in situ treatment of PCB-contaminated soils were evaluated.
- The AERIS expert system was completed and demonstrations of the program to a large number of government agencies and industrial associations indicated very positive support for the approach and the output generated.
- In addition to the AERIS program, six technical reports addressing site-specific clean-up criteria and field and laboratory evaluations of fate and transport algorithms were completed.

Future Challenges

- Develop in situ bioremediation treatment techniques for soils contaminated with pentachlorophenol.
- Promote the acceptability of risk assessment approaches, such as the AERIS expert system, to define clean-up criteria for site remediation.
- Develop an expert system in support of regulatory requirements for the remediation of contaminated sites.
- Undertake research and provide technical advice to the federal abandoned site remediation program.

LABORATORY DIVISION

The complexity and variety of wastes generated by Canada's industries and municipalities demand tremendous analytical capabilities to provide data for environmental research and technology development agencies. Many wastes contain a complicated mix of contaminants at varying concentrations. The nature of the material being analyzed often presents a challenge to instrumentation designed for less complicated matrices. In addition, exacting quality control and quality assurance standards are required to provide data for regulatory development, assessment and monitoring.



Research on analytical methods, advice on sampling protocols and data interpretation are essential services provided by the Laboratory Division

The Laboratory Division of the WTC has been very successful in meeting these requirements. Analytical support is provided to the three research and engineering divisions. Chemical analyses for conventional pollutants, toxic organics and toxic metals are conducted using chromatographs, mass spectrometers, atomic absorption and plasma emission spectrometers, scintillation counters and automated analyzers. The Laboratory Division provides advice on sampling protocols, data interpretation and quality assurance, and conducts research on analytical methods and enhanced sampling techniques.

Analytical support and advice is provided to other components of Environment Canada, and to various other federal agencies and provincial regulatory agencies. The Laboratory also analyzes legal samples in support of the Canadian Environmental Protection Act. All work conducted by the Laboratory Division is on a cost-recovery basis.

Recent Activities and Accomplishments

- The Laboratory Division is the lead Canadian agency in establishing an acceptable analytical methodology for the determination of Adsorbable Organic Halogen. The determination of this one parameter eliminates the need to analyze a large number of chlorinated organic compounds found in pulp mill effluents. A method has been developed and the laboratory recently carried out a major international round robin test.

- Comprehensive methods were developed for the simultaneous determination of chlorophenolics in pulp mill effluents. A similar method for analysis of resin and fatty acids was implemented. This work will support regulations being developed for the pulp and paper industry sector and for establishing best available treatment technology.

- New laboratory procedures are being examined to monitor airborne volatile organic compounds emitted from municipal and industrial waste treatment facilities.

- Phenolics, volatiles, 2,4-D, lindane, pentachlorophenol and metals in treatment plant influent, effluent, sludge streams and off-gases are being analyzed to determine whether they are being effectively treated.

- Isotope dilution mass spectrometry was successfully used for analyses of PAHs (polycyclic aromatic hydrocarbons) in sewage sludge.

Future Challenges

- Improve the accuracy of the analysis of priority pollutants in sewage sludge.

- Implement wider use of isotope dilution techniques to improve data quality from mass spectrometric analysis.

- Extend the use of canister and sorbant trapping techniques for the analysis of volatile and semi-volatile organics.

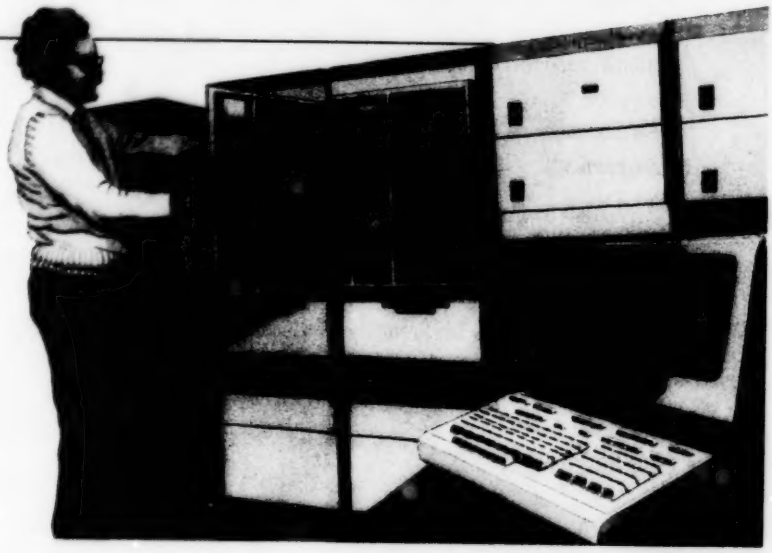
- Develop additional analytical methods for pulp mill effluents, for metals and other conventional parameters in fuels and heavy oils, and for speciation of metals in mining and metal finishing waste streams.

- Investigate new areas including: laboratory robotics to improve precision and sample throughput; a mobile laboratory to support field investigations of the other WTC divisions; biomonitoring techniques; standard reference materials for organic contaminants in municipal and industrial sludges.

- Expand the existing role of providing analytical services for outside clients.

COMPUTING AND INFORMATICS DIVISION

Research, technology development and transfer, analytical support and administrative support all have a common requirement - an innovative, high capacity state-of-the-art computing and information processing capability. The nature and amount of data generated within the WTC and from outside, along with new applications of computing in the fields of artificial intelligence and real-time process control, place tremendous demands on the Computing and Informatics Division. The WTC depends on this Division to support a host of applications involving 75 microcomputers and three HP1000 mini-computers.



Computer professionals provide real-time programming and expertise in data management

Computer support to the WTC can be categorized into two main areas: day-to-day trouble-shooting of hardware and software problems and the more substantial requirements of project specific activities involving custom programming. In addition, technology development in the wastewater field provides opportunities for innovative computer applications which may involve the development of marketable programs and systems.

Recent Activities and Accomplishments

- Assistance provided by the Computing and Informatics Division was instrumental in developing microcomputer-based real-time process control systems. These have been used in several projects, including an anaerobic pilot plant, automated temperature control at a greenhouse and a pilot scale treatment plant at Ville Mercier, Quebec.

- Two microcomputer-based dynamic modelling systems were also developed. One program predicts the fate of various toxic chemicals as they flow through the aerobic treatment process. The second was created to monitor the natural degradation of cyanide during treatment. Both systems are equipped with a third-party graphics package for producing plots and charts from operational information.

- Software was developed for an unattended real-time process control system operating at the sewage treatment plant in Tillsonburg, Ontario.

- Office automation activities recently resulted in the implementation of IBM micro-based systems in place of MICOM word processors in the Administrative Services Section. Intensive training sessions were undertaken and an overall increase in productivity has been achieved.

Future Challenges

- Provide computing expertise, hardware support and documentation for the development, operation and possible marketing of expert systems. Numerous programs within the WTC rely on these systems to assist the dynamic modelling component of waste treatment, regulatory development and process selection decision-making.

- Expand the Division's capabilities with regard to providing desk-top publishing services. Additional hardware, software and computer expertise will be required.

- Introduce an intercomputer communications network throughout the WTC allowing multi-user access to data and electronic mail capabilities.

- Increase involvement in joint projects with outside clients on a fee-for-service basis. This will require upgrading capabilities for the extraction of data from various spreadsheet programs and the generation of ASCII type output files for input into statistical programs.

- Upgrade capabilities in support of automated process control systems by acquiring commercial grade front-end packages such as the "FIX" system.

SUPPORT SERVICES DIVISION

The Support Services Division assists and enhances the day-to-day operation of the WTC and its various programs. Responsibilities range from financial and administrative to the design and operation of bench and pilot scale technologies. Activities in the Support Services Division are divided among five sections.

Technology transfer and financial management are essential services provided by the Support Services Division

Financial Management Services

- provides financial planning, control and tracking.

Materiel Management and Procurement Services

- purchases equipment, supplies and services, and manages the WTC inventory.

Administrative Services

- undertakes the administration of records, office and human resources.

Technology Transfer Services

- facilitates information exchanges and assists in the marketing of WTC technologies and expertise.

Engineering Support Services

- maintains and operates the building and undertakes the design, fabrication and construction of pilot scale facilities and instrumentation and control systems.

WASTEWATER TECHNOLOGY CENTRE CONTACTS

Director	Dr. B. E. Jank	(416) 336-4599 / 4740

BIOLOGICAL PROCESSES DIVISION

Chief	Dr. H. Melcer	(416) 336-4546

PHYSICAL/CHEMICAL PROCESSES DIVISION

Chief	Mr. J. W. Schmidt	(416) 336-4541

RESIDUE MANAGEMENT DIVISION

Chief	Mr. H. W. Campbell	(416) 336-4717

LABORATORY SERVICES DIVISION

Chief	Mr. P. J. A. Fowlie	(416) 336-4633

COMPUTING AND INFORMATICS DIVISION

Chief	Mr. B. Monaghan	(416) 336-4548

SUPPORT SERVICES DIVISION

Chief	Ms. C. D. Leacock	(416) 336-4667

General Information		(416) 336-4588
Fax		(416) 336-4765
Address	Wastewater Technology Centre 867 Lakeshore Road P. O. Box 5050 Burlington, Ontario L7R 4A6	